REMARKS/ARGUMENTS

In an Office Action mailed May 9, 2005 (the "Office Action"), the Examiner:

A. Rejected claims 22-26 under 35 U.S.C. 102(a) as being anticipated by Awano (U.S. Pat. Application Pub. 2002/0163079); and

B. Rejected claims 27-32 under 35 U.S.C. 102(a) as being anticipated by Dahl et al. (U.S. Pat. Application Pub. 2002/0130407).

Applicant thanks the Examiner for his discussion of the following remarks in a telephone interview on June 21, 2005. In the telephone interview, the Examiner indicated that he would analyze the Awano and Dahl references further and may look for additional references as well.

REMARKS

A. Rejection of claims 22-26 under 35 U.S.C. 102(a) as being anticipated by Awano (U.S. Pat. Application Pub. 2002/0163079).

Awano discloses "an integrated circuit device in which a cylindrical structure made up of carbon atoms [(carbon nanotubes)] is used as a material for a wiring member or a material for a via interconnecting wiring lines located in separate layers." (Awano paragraph 0002, emphasis added) Figure 4 in Awano discloses "an integrated circuit device of the invention comprising wiring members formed of carbon nanotubes." (Awano paragraph 0033, emphasis added) "In the integrated circuit device shown in the drawing, all of wiring lines 35, 35', vias 36, and contacts 37 are formed of carbon nanotube." (Awano paragraph 0087, emphasis added) Nothing in Awano discloses or suggests the heat conductive network claimed in claim 22, which is electrically isolated from the "wiring lines" (to use Awano's terminology).

In the Office Action, the Examiner asserts:

> Awano further discloses the contact structures/heat conductive vias/carbon nanotubes being electrically isolated from metal/via conductors of wiring

lines/interconnect levels (see 37 and 36 in Fig. 4) . . . (*underline added for emphasis*)

The Applicant respectfully disagrees with the Examiner's analysis, for the following reasons. Awano only discloses the use of carbon nanotubes (and/or other conductive material, such as metals) as electrical interconnects (variously called "wiring members", "wiring lines", "via[s] interconnecting wiring lines", and "contacts" by Awano). Awano does not disclose the use of carbon nanotubes (and/or other conductive material, such as metals) as part of a heat conductive network that is electrically isolated from the electrical interconnects. In particular, via 36 and contact 37 in Fig. 4 are part of the electrical interconnect, not electrically isolated therefrom.

Thus, Awano fails to teach a heat conductive network with "heat conductive vias being electrically isolated from metal conductors of said plurality of said interconnect levels" as required by independent claim 22 and dependent claims 23-26. Thus, Awano does not anticipate claims 22-26.

B. Rejection of claims 27-32 under 35 U.S.C. 102(a) as being anticipated by Dahl et al. (U.S. Pat. Application Pub. 2002/0130407).

Claim 27 has been cancelled. Dependent claims 28 and 29 have been rewritten as independent claims.

Dahl discloses "[n]ovel uses of diamondoid-containing materials in the field of microelectronics." (Dahl, abstract)

In Fig. 6B and the accompanying text, Dahl discloses "a diamondoid containing heat transfer film 620 is positioned adjacent to integrated circuit chip 601 and a heat sink 610. . . ." (Dahl, paragraph 0120) The heat sink may be made of copper. (Dahl, paragraph 0118)

In Fig. 6C and the accompanying text, Dahl discloses "heat pipes or heat conduits 631, 632 may be used to conduct heat away from the chip to a heat sink located remotely from the package" (Dahl, paragraph 0121) The "heat conduits . . . of FIG. 6C may

comprise any of the diamondoid-containing materials . . . ." (Dahl, paragraph 0122) The heat sink may be made of copper. (Dahl, paragraph 0118)

Claim 28:

In the Office Action, the Examiner asserts:

> Regarding claim 28, Dahl et al. disclose the entire claimed structure as applied to claim 27 above, wherein Dahl et al. teach using conventional heat spreading materials such as copper or aluminum (section 0118).

The Applicant respectfully disagrees with the Examiner's analysis, for the following reasons. Claim 28 requires that a heat conductive media comprising copper be contained within at least one cavity extending from the backside surface of a substrate. Nothing in Dahl discloses a heat conductive media comprising copper contained within at least one cavity extending from the backside surface of a substrate. Rather, Dahl discloses that heat conduits (e.g., 631 and 632) made of diamondoid-containing materials may be inserted into the chip. Copper is not a diamondoid-containing material.

In paragraph 0118, Dahl does disclose that heat sinks may be made of copper, but heat sinks (e.g., 610 in Fig. 6B and 630 in Fig. 6C) are separate and distinct from heat conduits (e.g., 631 and 632 in Fig. 6C). The only materials that Dahl discloses for the heat conduits are diamondoid-containing materials, not copper. Thus, Dahl does not anticipate claim 28 because Dahl does not disclose a heat conductive media comprising copper that is contained within at least one cavity extending from the backside surface of a substrate.

In addition, as stated in *Bristol-Myers Squibb Company v. Ben Venue Laboratories, Inc.*: "To anticipate, the reference must also enable one of skill in the art to make and use the claimed invention" (*Bristol-Myers Squibb Company v. Ben Venue Laboratories, Inc.*, 246 F.3d 1368, 1374 (Fed. Cir. 2001)). Here, even assuming for the sake of argument that Dahl discloses a heat conductive media comprising copper that is contained within at least one cavity extending from the backside surface of a substrate (an incorrect assumption), Dahl fails to enable one of skill in the art to make such a structure. Dahl's discussion of heat conduits is contained in paragraph 0121, which states:

> In this embodiment, heat pipes or heat conduits 631, 632 may be used to conduct heat away from the chip to a heat sink located remotely from the

> package. The heat conduits may be in fiber form, and may be inserted into the integrated circuit chip itself at locations 633, 634, or they may communicate with thermal vias (not shown) within the chip. The heat conducting conduits may be flexible fibers, or rigid rods. There may be from about 1 to 100 of the heat conducting fibers or rods.

There is no teaching in Dahl of: (1) how to make copper conduits in fiber form (either rigid or flexible); (2) how to insert from about 1 to 100 copper conduits into the chip; or (3) how to "communicate" with thermal vias (not shown). Thus, Dahl fails to enable one of skill in the art to make a heat conductive media comprising copper contained within at least one cavity extending from the backside surface of a substrate. Because Dahl fails to enable claim 28, Dahl also fails to anticipate claim 28.

Claims 29-32:

In the Office Action, the Examiner asserts that Dahl discloses:

> . . . cavities/holes being filled with heat conductive media (HCM) in a form of conducting conduits/thermal vias including highly thermally conductive material comprising a variety of diamond containing material, carbon nanotubes, etc. (sections 0007 and 0118-0122) . . . (*underline added for emphasis*)

The Applicant respectfully disagrees with the Examiner's analysis, for the following reasons. Claim 29 requires that a heat conductive media comprising carbon nanotubes be contained within at least one cavity extending from the backside surface of a substrate. Nothing in Dahl discloses a heat conductive media comprising carbon nanotubes contained within at least one cavity extending from the backside surface of a substrate. Rather, Dahl discloses that heat conduits (e.g., 631 and 632) made of diamondoid-containing materials may be inserted into the chip. Carbon nanotubes are not a diamondoid-containing material.

In the Background of the Invention, Dahl briefly mentions nanotubes as one of several forms of carbon:

> Carbon exists in other morphologies as well, including amorphous forms called "diamond-like carbon," and the highly symmetrical spherical and rod-shaped structures called "fullerenes" and "nanotubes", respectively. (Dahl, paragraph 0007)

> Another allotrope of carbon known as the fullerenes (and their counterparts carbon nanotubes) has been discussed by M.S. Dresslehaus et al. . . (Dahl, paragraph 0014)

Dahl mentions the well-known fact that nanotubes are a form of carbon, but Dahl discloses nothing more about nanotubes. Indeed, embodiments of Dahl's invention "are directed toward novel uses of diamondoid-containing materials in the field of microelectronics." (Dahl, Summary of the Invention, paragraph 0023) Carbon nanotubes are not diamondoids.

Thus, Dahl does not anticipate claim 29 because Dahl does not disclose a heat conductive media comprising carbon nanotubes that is contained within at least one cavity extending from the backside surface of a substrate.

In addition, as stated above: "To anticipate, the reference must also enable one of skill in the art to make and use the claimed invention" (*Bristol-Myers Squibb Company v. Ben Venue Laboratories, Inc.*, 246 F.3d 1368, 1374 (Fed. Cir. 2001)). Here, even assuming for the sake of argument that Dahl discloses a heat conductive media comprising carbon nanotubes that is contained within at least one cavity extending from the backside surface of a substrate (an incorrect assumption), Dahl fails to enable one of skill in the art to make such a structure. Dahl's discussion of heat conduits is contained in paragraph 0121, which states:

> In this embodiment, heat pipes or heat conduits 631, 632 may be used to conduct heat away from the chip to a heat sink located remotely from the package. The heat conduits may be in fiber form, and may be inserted into the integrated circuit chip itself at locations 633, 634, or they may communicate with thermal vias (not shown) within the chip. The heat conducting conduits may be flexible fibers, or rigid rods. There may be from about 1 to 100 of the heat conducting fibers or rods.

There is no teaching in Dahl of: (1) how to make carbon nanotube conduits in fiber form (either rigid or flexible); (2) how to insert from about 1 to 100 carbon nanotube conduits into the chip (or how to insert conduits made of any material for that matter); or (3) how to "communicate" with thermal vias (not shown). Thus, Dahl fails to enable one of skill in the art to make a heat conductive media comprising carbon nanotubes contained within at least one cavity extending from the backside surface of a substrate. Because Dahl fails to enable claim 29, Dahl also fails to anticipate claim 29.

Thus, Dahl does not anticipate claim 29 and dependent claims 30-32.

CONCLUSION

In light of the foregoing, the rejections in the Office Action mailed May 9, 2005 are believed to be traversed, and Applicant requests that the rejections be withdrawn and that the claims be passed to allowance.

If the Examiner believes a discussion of the above would be useful, he is invited to call the Applicant's attorney, Dr. Robert Beyers, at (650) 843-7528.

Respectfully submitted,

Date: June 22, 2005

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